See back cover for an English translation of this cover

2

91164M

911645

SUPERVISOR'S USE ONLY

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Tohua tēnei pouaka mēnā KĀORE koe i tuhi kōrero ki tēnei pukapuka

Mātai Matū, Kaupae 2, 2022

91164M Te whakaatu māramatanga ki te honohono, ki te hanganga, ngā āhuatanga me ngā huringa pūngao

Ngā whiwhinga: E rima

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki te honohono, ki te hanganga, ki ngā āhuatanga me ngā huringa pūngao.	Te whakaatu i te hōhonu o te māramatanga māramatanga ki te honohono, ki te hanganga, ki ngā āhuatanga me ngā huringa pūngao.	Te whakaatu i te matawhānui o te māramatanga ki te honohono, ki te hanganga, ki ngā āhuatanga me ngā huringa pūngao.

Tirohia mēnā e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.

He taka pūmotu kua takoto ki te Pukapuka Rauemi L2-CHEMR.

Ki te hiahia wāhi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka.

Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2–23 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ai te kauruku whakahāngai (). Ka poroa pea taua wāhi ka mākahia ana te pukapuka.

HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

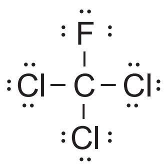
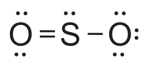
TE TŪMAHI TUATAHI

He pūhui ngā haurehu whakamātao ka whakamahia hei whakamātao, pērā i ngā mīhini whāhauhau me ngā pātaka mātao. E whakaaturia ana ki te tūtohi i raro nei ētahi o ngā haurehu whakamātao e whakamahia whānuitia ana.

(a) Tuhia te hoahoa Lewis (hoahoa tongi irahiko) mō ngā rāpoi ngota e whai ake nei, ka whakaingoa ai i ngā āhua.

Te rāpoi ngota	**NH_3**	**CO_2**	**N_2**
Te hoahoa Lewis			
Te ingoa o te āhua			

(b) He rāpoi ngota ngā mākōwaro (CFCs) i whakamahia whānuitia rā hei haurehu whakamātao i te tekau tau 1970 me te tekau tau 1980. Ko tētahi tauira ko te *trichlorofluoromethane,* CCl_3F, e kīia whānuitia ana ko te *freon-11*. E whakaaturia ana tēnei ki te tūtohi i raro nei, ki te taha o tētahi atu haurehu whakamātao, o te SO_2.

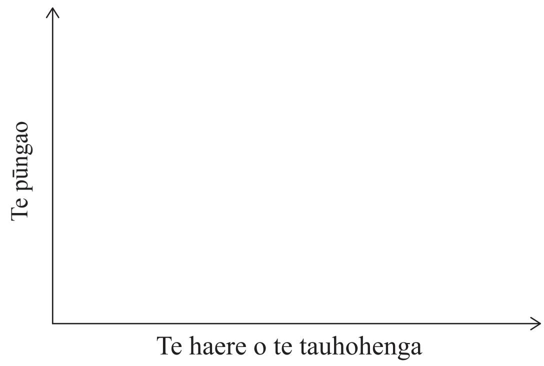
Te hoahoa Lewis		
Te ingoa	*Freon-11* (CCl_3F)	Hāora-rua pūngāwhā (SO_2)
Te koki hononga	109.5°	120°

Whakatairitea, whakatauarotia hoki ngā āhua me ngā koki hononga o te *freon-11* ki te SO_2.

(c) Ko tā te *Freon-11*, CCl_3F, he mahi hei haurehu whakamātao i roto i te pātaka mātao, mā te whakaeto, arā, e whakaaturia ana ki te whārite i raro nei.

$$CCl_3F(\ell) \rightarrow CCl_3F(g) \qquad \Delta_r H = +25.2 \text{ kJ mol}^{-1}$$

(i) Tuhia tētahi hoahoa pūngao e whai tapanga ana mō te whakaeto o te *freon-11* e whakaatu nei i ngā matū hohe, i ngā hua, me te panonitanga o te hāwera ($\Delta_r H$).



Ki te hiahia koe ki te tā anō i tō urupare, whakamahia ngā tuaka kei te whārangi 20.

(ii) Mā te kōrero mō te panonitanga o te hāwera me ngā tōpana kume i waenga i ngā korakora i roto i te *freon-11*, whakamāramahia mai te āhua e taea ai tēnei tukanga te whakamahi hei whakamātao iho i tētahi pātaka mātao.

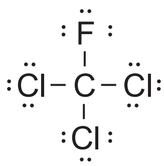
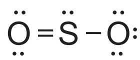
QUESTION ONE

Refrigerants are compounds that are used for cooling, such as in air conditioning units and refrigerators. Some commonly used refrigerants are shown in the table below.

(a) Draw the Lewis diagram (electron dot diagram) for the following molecules and name their shapes.

Molecule	**NH_3**	**CO_2**	**N_2**
Lewis diagram			
Name of shape			

(b) Chlorofluorocarbons (CFCs) were molecules commonly used as refrigerants in the 1970s and 1980s. One such example is trichlorofluoromethane, CCl_3F, commonly referred to as freon-11. It is shown in the table below, with another refrigerant, SO_2.

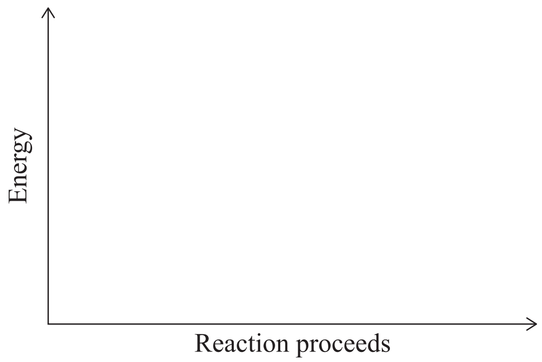
Lewis diagram		
Name	Freon-11 (CCl_3F)	Sulfur dioxide (SO_2)
Bond angle	109.5°	120°

Compare and contrast the shape and bond angles of freon-11 with SO_2.

(c) Freon-11, CCl_3F, works as a refrigerant in a refrigerator by evaporating, as shown in the equation below.

$CCl_3F(\ell) \rightarrow CCl_3F(g) \qquad \Delta_rH = +25.2 \text{ kJ mol}^{-1}$

(i) Draw a labelled energy diagram for the evaporation of freon-11, showing reactants, products, and the change in enthalpy (Δ_rH).

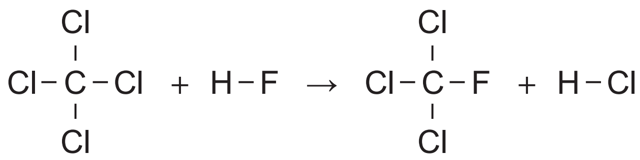


If you need to redraw your response, use the axes on page 21.

(ii) By referring to both the change in enthalpy and the attractive forces between particles in freon-11, explain how this process can be used to cool down a refrigerator.

TE TŪMAHI TUARUA

(a) Ka whakaputaina te *Freon-11*, $CCl_3F(g)$ i te taiwhanga pūtaiao, mā te tauhohenga o te waro *tetrachloride*, $CCl_4(g)$, ki te hauwai pūkōwhai, arā, ki te $HF(g)$, e whakaaturia ana ki te tauhohenga i raro nei.



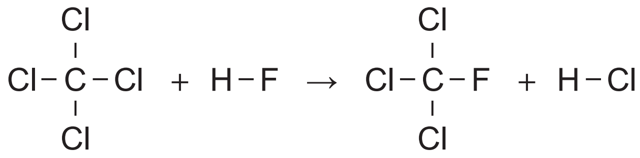
$\Delta_r H° = –21$ kJ mol^{-1}

(i) Whakamahia te panonitanga o te hāwera ($\Delta_r H°$) mō te tauhohenga i runga nei me ngā pūngao hononga e rārangi mai ana i te tūtohi i raro nei hei tātai i te pūngao hononga toharite mō te hononga C–Cl.

Te hononga	Te pūngao hononga toharite (kJ mol^{-1})
C–F	485
H–F	567
H–Cl	431

QUESTION TWO

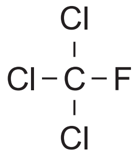
(a) Freon-11, $CCl_3F(g)$, is produced in the lab by the reaction of carbon tetrachloride, $CCl_4(g)$, with hydrogen fluoride, $HF(g)$, as shown in the reaction below.



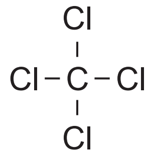
$\Delta_r H° = –21$ kJ mol$^{–1}$

(i) Use the change in enthalpy ($\Delta_r H°$) for the reaction above and the bond energies listed in the table below to calculate the average bond energy of the C–Cl bond.

Bond	**Average bond energy (kJ mol$^{–1}$)**
C–F	485
H–F	567
H–Cl	431



Freon-11 (CCl_3F)

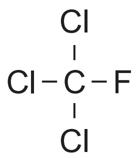


Carbon tetrachloride (CCl_4)

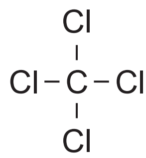
(ii) Porohitatia te kupu kua tāmiramirahia i raro nei e pai katoa ana hei whakaahuatanga mō te pitoruatanga o ia rāpoi ngota.

Freon-11 (CCl_3F)	**Pitorua**	**Pitokore**
Carbon tetrachloride (CCl_4)	**Pitorua**	**Pitokore**

(iii) Whakatairitea, whakatauarotia hoki ngā take e whai pānga ana ki te pitoruatanga o ēnei rāpoi ngota e rua.



Freon-11 (CCl_3F)



Carbon tetrachloride (CCl_4)

(ii) Circle the word in bold below that best describes the polarity of each molecule.

Freon-11 (CCl_3F)	**Polar**	**Non-polar**
Carbon tetrachloride (CCl_4)	**Polar**	**Non-polar**

(iii) Compare and contrast the factors that influence the polarity of these two molecules.

(b) I tautuhia te *Freon-11* hei take hāpai i te puare i te paparanga hāora-toru, ā, i katia tōna whakamahinga i te tau 1987. I te kōhauhau o runga, ka tāharaharatia e te *freon-11* te hāora-toru, $O_3(g)$.

E whakaaturia ana i raro nei te tauhohenga whānui mō te tāharaharatanga o te hāora-toru, $O_3(g)$, kia hāora rehu, $O_2(g)$.

$$2O_3(g) \rightarrow 3O_2(g) \qquad \Delta_r H = -285 \text{ kJ mol}^{-1}$$

Tātaihia te nui o te pūngao ka tukuna ina tāharaharatia te 126 g o te hāora-toru kia hāora rehu, $O_2(g)$.

$M(O_3) = 48.0 \text{ g mol}^{-1}$

(b) Freon-11 was identified as contributing to the hole in the ozone layer and was banned in 1987. In the upper atmosphere, freon-11 causes the decomposition (breaking down) of ozone, $O_3(g)$.

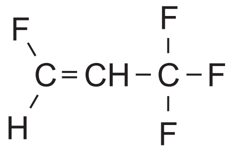
The overall reaction for the decomposition of ozone, $O_3(g)$ into oxygen gas, $O_2(g)$, is shown below.

$$2O_3(g) \rightarrow 3O_2(g) \qquad \Delta_r H = -285 \text{ kJ mol}^{-1}$$

Calculate the amount of energy released when 126 g of ozone, $O_3(g)$, is decomposed into oxygen gas, $O_2(g)$.

$M(O_3) = 48.0 \text{ g mol}^{-1}$

(c) E whakaaturia ana i raro nei tētahi haurehu whakamātao hou, te Pūhui A, $C_3H_2F_4(g)$, ka kore e tūkino i te paparanga hāora-toru, ka kore hoki e noho hei haurehu kati mahana.

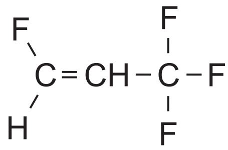


(i) Whakarōpūtia te Pūhui A hei katote rānei, hei huinga rāpoi ngota rānei, hei whairino rānei, hei whatunga matū ngota rānei.

(ii) E whai hua ai ngā haurehu whakamātao, me whakaeto ki tētahi haurehu e ōrite ana tōna pāmahana ki tō te rūma.

Mā te whakamahi i ō mōhiotanga ki te hanganga me te honohono, whakamāramahia mai te take e whakaeto ai te Pūhui A i te pāmahana o te rūma.

(c) A modern refrigerant, Compound A, $C_3H_2F_4(g)$, that neither damages the ozone layer nor acts as a greenhouse gas, is shown below.



(i) Classify Compound A as either an ionic, molecular, metallic, or covalent network substance.

(ii) Refrigerants need to readily evaporate into a gas at room temperature to be effective.

Using your knowledge of structure and bonding, explain why Compound A is able to evaporate at room temperature.

TE TŪMAHI TUATORU

(a) Whakaotia te tūtohi i raro nei mō ngā matū i roto i ō rātou āhuatanga totoka.

Totoka	Te tūmomo totoka	Te tūmomo korakora	Ngā tōpana kume i waenga i ngā korakora
Freon-11 $CCl_3F(s)$			
Taimana $C(s)$			
Lithium bromide $LiBr(s)$			

(b) Ka hua māori mai te waro, $C(s)$, hei matāpango, hei taimana hoki. Ka pātere te kawe a te matāpango i te hiko, he ārai hiko kē ia te taimana.

Whakamahia ō mōhiotanga ki te hanganga me te honohono hei whakamārama i tēnei rerekētanga i roto i te kakawe hiko.

QUESTION THREE

(a) Complete the following table for the substances in their solid states.

Solid	Type of solid	Type of particle	Attractive forces between particles
Freon-11 $CCl_3F(s)$			
Diamond $C(s)$			
Lithium bromide $LiBr(s)$			

(b) Carbon, $C(s)$, occurs naturally as both graphite and diamond. Graphite readily conducts electricity, while diamond is an electrical insulator.

Use your knowledge of structure and bonding to explain this difference in electrical conductivity.

(c) Ka tere tonu te memeha o te *lithium bromide* totoka i roto i te wai, o te LiBr(s), e whakaaturia ana ki te whārite i raro nei.

$LiBr(s) \rightarrow Li^{+}(aq) + Br^{-}(aq) \quad \Delta_r H = -48.8 \text{ kJ mol}^{-1}$

(i) Whakarōpūtia tēnei tukanga hei putawera, hei pauwera rānei, ka mutu, homai tētahi pūtake.

(ii) E whakaaturia ana i raro nei te whārite mō te memehatanga o te *potassium bromide* totoka, KBr(s), i roto i te wai.

$KBr(s) \rightarrow K^{+}(aq) + Br^{-}(aq) \quad \Delta_r H = +19.9 \text{ kJ mol}^{-1}$

Ka whakarewaina te *lithium bromide*, te LiBr(s) i tētahi ipurau, me te *potassium bromide* totoka, me te KBr(s), i tētahi atu, e 200 ml te rōrahi o te wai i ia ipurau. Ka whakarewaina te 20.0 g o te LiBr i te ipurau tuatahi, ka hua mai he huringa pūngao.

Tātaihia te papatipu o te *potassium bromide* totoka, KBr(s), me whakarewa i roto i te ipurau tuarua e ōrite ai te kaha o te huringa pūngao.

$M(\text{LiBr}) = 86.8 \text{ g mol}^{-1} \quad M(\text{KBr}) = 119 \text{ g mol}^{-1}$

(iii) Mā te whakaaro ki te panonitanga o te hāwera i ia tukanga, whakamāramahia mai ētahi rerekētanga i roto i ngā pāmahana whakamutunga o ia mehanga.

Ehara i te mea me puta ētahi tātaitanga i tō tuhinga.

Ka rere tonu te Tūmahi Tuatoru i te whārangi e whai ake nei.

(c) Solid lithium bromide, LiBr(s), readily dissolves in water, as shown in the equation below.

$LiBr(s) \rightarrow Li^+(aq) + Br^-(aq) \quad \Delta_r H = -48.8 \text{ kJ mol}^{-1}$

(i) Classify this process as exothermic or endothermic, with a reason.

(ii) The equation for the dissolving of solid potassium bromide, KBr(s), in water, is shown below.

$KBr(s) \rightarrow K^+(aq) + Br^-(aq) \qquad \Delta_r H = +19.9 \text{ kJ mol}^{-1}$

Both lithium bromide, LiBr(s), and solid potassium bromide, KBr(s), are dissolved in 200 ml of water, in separate beakers. 20.0 g of LiBr is dissolved in the first beaker, resulting in an energy change.

Calculate the mass of solid potassium bromide, KBr(s), that would need to be dissolved in the second beaker in order to have an energy change of equal magnitude (size).

$M(\text{LiBr}) = 86.8 \text{ g mol}^{-1} \qquad M(\text{KBr}) = 119 \text{ g mol}^{-1}$

(iii) By considering the enthalpy change of each process, explain any difference in the resultant temperatures of each solution.

No calculations are needed in your answer.

Question Three continues on the next page.

(iv) Whakamahia ō mōhiotanga ki te hanganga me te honohono hei whakamārama i te take ka rewa te *lithium bromide* totoka, LiBr(*s*), i roto i te wai.

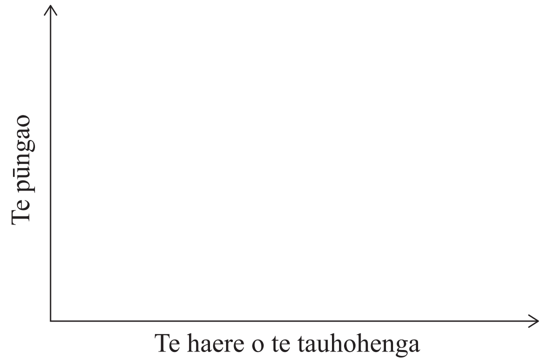
Me whakamahi rawa he hoahoa i tō tuhinga hei whakaahua i te tukanga whakarewa.

(iv) Use your knowledge of structure and bonding to explain why solid lithium bromide, LiBr(*s*), dissolves in water.

Use of a diagram is required in your answer to illustrate the dissolving process.

HE HOAHOA WĀTEA

Ki te hiahia koe ki te tā anō i tō urupare ki te Tūmahi Tuatahi (c)(i), whakamahia te kauwhata i raro nei. Kia mārama te tohu ko tēhea te tuhinga ka hiahia koe kia mākahia.

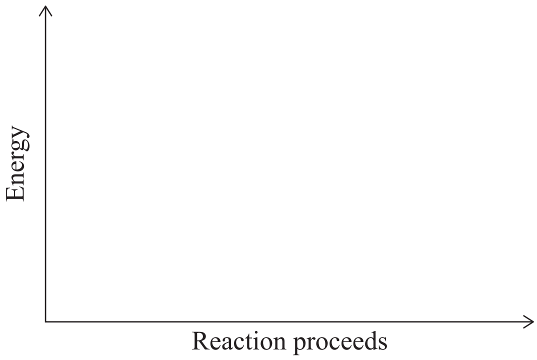


He wāhi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

SPARE DIAGRAMS

If you need to redraw your response to Question One (c)(i), use the graph below. Make sure it is clear which answer you want marked.



Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

English translation of the wording on the front cover

Level 2 Chemistry 2022

91164M Demonstrate understanding of bonding, structure, properties and energy changes

Credits: Five

91164M

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of bonding, structure, properties and energy changes.	Demonstrate in-depth understanding of bonding, structure, properties and energy changes.	Demonstrate comprehensive understanding of bonding, structure, properties and energy changes.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

A periodic table is provided in the Resource Booklet L2–CHEMR.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–23 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area ( ). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.